

<b>TIMSS CONTENT</b>	<b>ADP Benchmarks: Mathematics</b>	<b>Kentucky Mathematics Program of Studies</b>	<b>Core Content for Assessment (Draft)</b> <i>Bold – State Assessment Content Statement</i> <i>Italics – Supporting Content Statement</i>	<b>Kentucky College Readiness Standards LEVELS: 1-2-3</b>
	Certain mathematics benchmarks are marked with an <b>asterisk (*)</b> . These asterisked benchmarks represent <b>content that is recommended for all students, but is required for those students who plan to take calculus</b> in college, a requisite for mathematics and many mathematics intensive majors.			LEVEL 1-all entering college students  <b>LEVEL 2- can be acquired in a college-level course</b>  <b>LEVEL 3- content that is required for those students who plan to take calculus</b> in college, a requisite for mathematics and many mathematics intensive majors.
<b>1.1 NUMBER</b>	<b>I. Number Sense and Numerical Operations</b> - The high school graduate can:		<b>Number Properties and Operations</b> Students should enter high school with a strong background in rational numbers and numerical operations and expand this to real numbers. This becomes the foundation for algebra and working with algebraic symbols. They understand large and small numbers and their representations, powers and roots. They compare and contrast properties of numbers and number systems and develop strategies to estimate the results of operations on real numbers.	<b>NUMBER/OPERATIONS</b>
<b>1.1.3 Integer, Rational &amp; Real Numbers - Operations &amp; Properties</b>	<b>II. Compute with rational numbers fluently and accurately without a calculator:</b>			<b>A. Compute fluently and accurately with rational numbers without a calculator:</b>

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	I1.1. Add, subtract, multiply and divide integers, fractions and decimals.	M-8-NC-1 Students will use percents, decimals, integers, and fractions (include percents less than 1)	<p>MA-H11-1.3.1</p> <p>Students will simplify real number expressions in mathematical problems (including addition, subtraction, multiplication, division, absolute value, integer exponents, roots [square, cube], factorials), and will use these expressions to solve real-world problems to a specified accuracy.</p> <p>MA-M8-1.3.1</p> <p>Students will identify and describe when addition, subtraction, multiplication and division are appropriate in real-world and mathematical situations, and use algorithms and order of operations (including positive whole number exponents) to solve real-world and mathematical problems involving rational numbers.</p>	Add, subtract, multiply and divide integers, fractions and decimals.

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1.5.2 Proportionality problems Ratios, proportions, rates	<b>I1.2</b> Calculate and apply ratios, proportions, rates, and percentages to solve problems	M-H-A-11 Students will write and solve proportion sentences.  M-H-A-12 Students will use proportional reasoning (ratios and proportions) to solve real-world problems.  M-H-A-13 Students will solve problems that have direct or inverse relationships for any variable  <i>M-8-NC-2 Students will use percentages and proportions in consumer applications (e.g., simple interest, percentages of increase or decrease, discounts, unit pricing, sales prices)</i>  <i>M-8-GM-2 derive and use formulas for various rates (e.g., distance/time, miles per hour)</i>	<b>MA-H11-1.4.1 Students will use ratios and proportional reasoning to solve real-world and/or mathematical problems (e.g., those involving slope and rate) and will explain how slope shows a rate of change in linear functions representing real- world problems.</b>  <b>MA-M8-1.4.1</b>  <b>Students will use ratios and proportional reasoning to solve real-world (e.g., percentage, constant rate of change, unit pricing, increase, decrease) and/or mathematical problems.</b>	Calculate and apply ratios, proportions, rates, and percentages to solve problems
1.1.5.4 Orders of magnitude	<b>I1.5.</b> Multiply and divide numbers expressed in scientific notation.		<i>MA-H11-1.1.1c</i> <i>Students will use scientific notation to express very large or very small quantities.</i>	Multiply and divide numbers expressed in scientific notation
	<b>I2. Recognize and apply magnitude (absolute value) and ordering of real numbers:</b>		<i>MA-H11-1.1.1a</i> <i>Students will use order relations (less than, greater than, equal to) to represent problems using real numbers.</i>	<b>B. . Recognize and apply magnitude (absolute value) and ordering of real numbers:</b>
	<b>I2.1.</b> Locate the position of a number on the number line, know that its distance from the origin is		<b>MA-H11-1.3.1</b> <b>Students will simplify real</b>	Locate the position of a number on the number line, know that its distance from the origin is its

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	its absolute value and know that the distance between two numbers on the number line is the absolute value of their difference.		<b>number expressions in mathematical problems (including addition, subtraction, multiplication, division, <u>absolute value</u>, integer exponents, roots [square, cube], factorials), and will use these expressions to solve real-world problems to a specified accuracy.</b>	absolute value and know that the distance between two numbers on the number line is the absolute value of their difference.
	<b>I2.2.</b> Determine the relative position on the number line of numbers and the relative magnitude of numbers expressed in fractional form, in decimal form, as roots or in scientific notation.	<b>M-8-NC-4</b> Students will relate irrational and rational numbers (e.g., magnitude, order on a number line).	<i>MA-H11-1.1.1a Students will use order relations (less than, greater than, equal to) to represent problems using real numbers.</i>  <b>MA-M8-1.1.2</b> Students will convert among rational numbers, and will order and compare rational numbers and irrational numbers (square roots and $\pi$ only)..	Determine the relative position on the number line of numbers and the relative magnitude of numbers expressed in fractional form, in decimal form, as roots or in scientific notation.

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Properties of Operations	I1.3. Use the correct order of operations to evaluate arithmetic expressions, including those containing parentheses.	<p>M-7-NC-12 Students will explain and apply properties (e.g., commutative, associative, distributive, inverse, identity).</p> <p>M-H-A-2 Students will solve two-variable linear equations using real numbers, real number operations, field properties, <b>and order of operations.</b></p>	<p><b>MA-M8-5.2.1</b> <b>Students will evaluate and simplify numerical and algebraic expressions using the order of operations.</b></p> <p><b>MA-M8-1.3.1 Students will identify and describe when addition, subtraction, multiplication and division are appropriate in real-world and mathematical situations, and use algorithms and <u>order of operations</u> (including positive whole number exponents) to solve real-world and mathematical problems involving rational numbers.</b></p>	Use the correct order of operations to evaluate arithmetic expressions, including those containing parentheses.
1.1.4 Other Number & Number Concepts:			<p><i>MA-H11-1.5.1a</i> <i>Students will use equivalence relations (reflexive, symmetric, transitive) to solve problems using real numbers</i></p>	

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1.1.4.2 Exponents, Roots And Radicals		<p>M-8-NC-3 Students will use irrational numbers (e.g., square roots).</p> <p>M-8-NC-5 Students will determine the inverse relationship between addition and subtraction, multiplication and division, or raising to an exponent and taking the root of a number.</p>	<p>MA-H11-1.3.1 Students will simplify real number expressions in mathematical problems (including addition, subtraction, multiplication, division, absolute value, <b>integer exponents, roots</b> [square, cube], factorials), and will use these expressions to solve real-world problems to a specified accuracy.</p>	
1.1.4.3 Complex Numbers And Their Properties	<p>I3. Understand that to solve certain problems and equations, number systems need to be extended from whole numbers to the set of all integers (positive, negative and zero), from integers to rational numbers, from rational numbers to real numbers (rational and irrational numbers) and from real numbers to complex numbers; define and give examples of each of these types of numbers.</p>		<p>MA-H11-1.1.1b <i>Students will demonstrate the relationships between different subsets of the real number system</i> <b>NO COMPLEX</b></p>	<p>C. Understand that to solve certain problems and equations, number systems need to be extended from whole numbers to the set of all integers (positive, negative and zero), from integers to rational numbers, from rational numbers to real numbers (rational and irrational numbers) and from real numbers to complex numbers; define and give examples of each of these types of numbers</p>
1.1.4.4 Number Theory	<p>I1.4. Explain and apply basic number theory concepts such as prime number, factor, divisibility, least common multiple and greatest common divisor.</p>	<p>M-6-NC-6 Students will determine prime numbers, composite numbers, factors, multiples, greatest common factors, and least common multiples.</p> <p>M-6-NC-11 Students will use prime numbers, composite numbers, factors.</p>	<p><b>MA-M7-1.5.1</b> <b>Students will identify and use prime numbers, composite numbers, prime factorization, factors, multiples and divisibility to solve real world and/or mathematical problems (e.g.,</b></p>	<p>Explain and apply the basic number theory concepts such as prime number, factor, divisibility, least common multiple, and greatest common divisor.</p>

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		multiples, and divisibility to solve problems.	<b>prime factorization to determine a least common multiple [LCM] or greatest common factor [GCF]).</b>	
<b>Technology</b> (not a TIMSS content category)	<b>I4. Understand the capabilities and the limitations of calculators and computers in solving problems:</b>			<b>A. Understand the capabilities and the limitations of calculators and computers in solving problems:</b>
	<b>I4.1.</b> Use calculators appropriately and make estimations without a calculator regularly to detect potential errors.			Use calculators appropriately and make estimations without a calculator regularly to detect potential errors.
	<b>I4.2.</b> Use graphing calculators and computer spreadsheets.			Use graphing calculators and computer spreadsheets.
<b>1.1.5 Estimation And Number Sense Concepts</b> (estimating, rounding, mental math and reasonableness)			<i>MA-H11-1.2.1a Students will estimate solutions to problems with real numbers (including very large and very small quantities) in both real world and mathematical situations, and use the estimations to check for reasonable computational results.</i>  <b>MA-M8-1.2.1 Students will estimate to solve real-world and/or mathematical problems with rational numbers, checking for reasonable and appropriate computational results.</b>	

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			<i>MA-M8-1.3.1b</i> <i>Students will check reasonable and appropriate computational results, using a variety of methods (e.g., estimate, pencil and paper, calculator, round, mental math).</i>	
<b>1.6.2 Expressions, Equations Inequalities &amp; Formulas</b>	<b>J. Algebra</b> - The high school graduate can:		High school students extend analysis and use of functions and focus on linear, quadratic, absolute value and exponential functions. They explore parametric changes on graphs of functions. They use rules and properties to simplify algebraic expressions. They combine simple rational expressions and combine simple polynomial expressions. They factor polynomial expressions and quadratics of the form $1x^2 + bx + c$ .	<b>ALGEBRA</b>
Expressions	<b>J1. Perform basic operations on algebraic expressions fluently and accurately:</b>	<i>M-7-A-4</i> <i>Students will simplify numeric and algebraic expressions.</i>  <i>M-8-A-5</i> <i>Students will simplify algebraic expressions.</i>	<b>MA-H11-1.5.1</b> Students will identify and explain how real number properties (e.g., commutative, associative, distributive, identity and inverse) are used to justify a given step in simplifying an expression or solving an equation <b>MA-M8-5.2.1</b> Students will evaluate and simplify numerical and algebraic expressions using the order of operations.	<b>D. Perform basic operations on algebraic expressions fluently and accurately:</b>



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	<b>J1.1.</b> Understand the properties of integer exponents and roots and apply these properties to simplify algebraic expressions.		<b>MA-H11-5.2.1</b> <b>Students will use order of operations, real number properties (identity, inverse, commutative, associative, distributive, closure), and rules of exponents (integer) to simplify algebraic expressions.</b>	Understand the properties of integer exponents and roots and apply these properties to simplify algebraic expressions.
	<b>J1.2.</b> * Understand the properties of rational exponents and apply these properties to simplify algebraic expressions.			Understand the properties of rational exponents and apply these properties to simplify algebraic expressions.
	<b>J1.3.</b> Add, subtract and multiply polynomials; divide a polynomial by a low degree polynomial.		<b>MA-H11-5.2.2</b> <b>Students will add, subtract, and multiply polynomial expressions; will factor polynomial expressions using the greatest common monomial factor; and will factor quadratic polynomials of the form <math>ax^2+bx+c</math>, when <math>a=1</math> and <math>b</math> and <math>c</math> are integers.</b>	Add, subtract and multiply polynomials; divide a polynomial by a low degree polynomial.

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	<b>J1.4.</b> Factor polynomials by removing the greatest common factor; factor quadratic polynomials.		<p><b>MA-H11-5.2.2</b> Students will add, subtract, and multiply polynomial expressions; will factor polynomial expressions using the greatest common monomial factor; and will factor quadratic polynomials of the form <math>ax^2+bx+c</math>, when <math>a=1</math> and <math>b</math> and <math>c</math> are integers.</p> <p><i>MA-H11-5.2.2a</i> Students will factor quadratic polynomials, such as perfect square trinomials and quadratic polynomials of the form <math>ax^2 + bx + c</math> when <math>a \neq 1</math> and <math>b</math> and <math>c</math> are integers.</p>	Factor polynomials by removing the greatest common factor; factor quadratic polynomials.
	<b>J1.5.</b> Add, subtract, multiply, divide and simplify rational expressions.		<p><b>MA-H11-5.2.3</b> Students will add, subtract, multiply, and divide simple rational expressions with monomial first-degree denominators and whole number numerators (e.g., <math>\frac{1}{x} + \frac{2}{y}</math>; <math>\frac{1}{x} - \frac{1}{y}</math>; <math>\frac{1}{x} \times \frac{1}{y}</math>; <math>\frac{1}{x} \div \frac{1}{y}</math>).</p>	Add, subtract, multiply, divide and simplify rational expressions.

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	<b>J1.6.</b> Evaluate polynomial and rational expressions and expressions containing radicals and absolute values at specified values of their variables.			Evaluate polynomial and rational expressions and expressions containing radicals and absolute values- at specified values of their variables.
<b>1.6.1 Patterns, Functions And Relationships</b>	<b>J2 Understand functions, their representations and their properties:</b>			<b>E. Understand functions, their representations and their properties:</b>

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	<b>J2.1</b> Recognize whether a relationship given in symbolic or graphical form is a function		<b>MA-H11-5.1.2</b> <b>Students will:</b> <ul style="list-style-type: none"> <li>Recognize an example of a function;</li> <li>Identify the role of independent and dependent variables in a function;</li> <li>Find the slope and intercepts of a linear function;</li> <li>Find the maximum, minimum, and intercepts of a quadratic function; and</li> </ul>	Recognize whether a relationship given in symbolic or graphical form is a function
	<b>J2.2.</b> * Determine the domain of a function represented in either symbolic or graphical form.		<ul style="list-style-type: none"> <li>Determine the domain and range of a function (linear and quadratic);</li> </ul>	Determine the domain of a function represented in either symbolic or graphical form.
	<b>J2.3.</b> Understand functional notation and evaluate a function at a specified point in its domain.		<ul style="list-style-type: none"> <li>Use function notation to evaluate a function for a specified integer value.</li> </ul>	Understand functional notation and evaluate a function at a specified point in its domain.

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	<b>J2.4.</b> * Combine functions by composition, as well as by addition, subtraction, multiplication and division.			Combine functions by composition, as well as by addition, subtraction, multiplication and division.
	<b>J2.5.</b> * Identify whether a function has an inverse and when functions are inverses of each other; explain why the graph of a function and its inverse are reflections of one another over the line $y = x$ .			Identify whether a function has an inverse and when functions are inverses of each other; explain why the graph of a function and its inverse are reflections of one another over the line $y = x$ .
	<b>J2.6.</b> * Know the inverse of an exponential function is a logarithm, prove basic properties of a logarithm using properties of its inverse and apply those properties to solve problems.			Know the inverse of an exponential function is a logarithm, prove basic properties of a logarithm using properties of its inverse and apply those properties to solve problems.

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Equations	<b>J3. Apply basic algebraic operations to solve equations and inequalities:</b>		<b>MA-H11-1.5.1</b> Students will identify and explain how real number properties (e.g., commutative, associative, distributive, identity and inverse) are used to justify a given step in simplifying an expression or solving an equation	<b>F. Apply basic algebraic operations to solve equations and inequalities:</b>
Other Algebra Content			<i>MA-H11-5.1.1a</i> <i>Students will identify, relate, and</i> <i>apply representations (graphs,</i> <i>equations, tables) of a piecewise</i> <i>function (such as long distance</i> <i>telephone rates) from</i> <i>mathematical or real world</i> <i>information.</i>  <i>MA-H11-5.1.2a</i> <i>Students will find the domain and</i> <i>range for absolute value functions.</i>  <i>MA-H11-5.1.2b</i> <i>Students will apply and use direct</i> <i>and inverse variation to solve real</i> <i>world and mathematical problems.</i>	

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	J3.1. Solve <b>linear equations</b> and <b>inequalities</b> in one variable including those involving the <b>absolute value</b> of a linear function.	<p>M-H-A-1 Students will solve one-variable equations using manipulatives, symbols, procedures, and graphing.</p> <p>M-H-A-6 Students will connect the skills to solve linear equations to solve linear inequalities.</p> <p>M-H-A-7 Students will write and solve linear inequalities.</p> <p>M-8-A-6 Students will investigate inequalities using a variety of methods and representations.</p>	<p><b>MA-H11-5.1.1</b> <b>Students will identify and use multiple representations (tables, graphs, equations) of functions (linear, quadratic, absolute value, exponential) to solve real-world and/or mathematical problems.</b></p> <p><b>MA-H11-5.3.1</b> <b>Students will write and/or solve first degree, single variable equations and inequalities, including absolute value, in real-world and/or mathematical situations, and will graph the solutions on a number line.</b></p> <p><b>MA-M8-5.3.1</b> <b>Students will represent and write one- and two-step single variable equations and inequalities, e.g., <math>4x+2=22</math>, <math>x-4&lt;-60</math>, and will use them to solve real-world and/or mathematical problems.</b></p>	Solve <b>linear equations</b> and <b>inequalities</b> in one variable including those involving the <b>absolute value</b> .

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	<b>J3.2.</b> Solve an equation involving several variables for one variable in terms of the others.	M-H-A-2 Students will solve two-variable linear equations using real numbers, real number operations, field properties, and order of operations.	MA-H11-5.3.1a <i>Students will solve for a specified variable in a multivariable equation.</i>  <b>MA-H11-5.3.2</b> <b>Students will write and/or solve first degree, two-variable equations and inequalities in real-world and/or mathematical situations, and will graph the solutions on a coordinate plane.</b>	Solve an equation involving several variables for one variable in terms of the others.
	<b>J3.3.</b> Solve systems of two linear equations in two variables.		<b>MA-H11-5.3.3</b> <b>Students will write and graph systems of linear equations (two equations in two variables), use the system to solve and interpret real-world and/or mathematical problems.</b>  <i>MA-H11-5.3.3a</i> <i>Students will write, graph, and solve systems of linear inequalities (two inequalities in two variables) based on real world or mathematical situations and interpret the solution.</i>	Solve systems of two linear equations in two variables.
	<b>J3.4. *</b> Solve systems of three linear equations in three variables.			



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	J3.5. Solve quadratic equations in one variable.	M-H-A-8 Students will use the skills learned to solve linear equations and inequalities to solve numerically, graphically, or symbolically non-linear equations such as quadratic and exponential equations.	<p><b>MA-H11-5.1.1</b> Students will identify and use multiple representations (tables, graphs, equations) of functions (linear, quadratic, absolute value, exponential) to solve real-world and/or mathematical problems.</p> <p><b>MA-H11-5.3.4</b> Students will solve quadratic equations from real world or mathematical situations.</p>	Solve quadratic equations in one variable.

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Graphing	J4. Graph a variety of equations and inequalities in two variables, demonstrate understanding of the relationships between the algebraic properties of an equation and the geometric properties of its graph, and interpret a graph:	M-H-A-3 Students will write and solve linear sentences, describing real-world situations by using and relating formulas, tables, graphs, and equations.	<p>MA-H11-5.1.1b Students will demonstrate how equations and graphs are models of the relationship between two real world quantities (e.g., the relationship between degrees Celsius and degrees Fahrenheit)</p> <p>MA-H11-5.1.3 Students will identify the changes and explain how changes in parameters affect graphs of functions (e.g., compare <math>y=x^2</math>, <math>y=2x^2</math>, <math>y=(x-4)^2</math>, and <math>y=x^2+3</math>).</p> <p>MA-H11-5.3.1 Students will write and/or solve first degree, single variable equations and inequalities, including absolute value, in real-world and/or mathematical situations, and will graph the solutions on a number line.</p> <p>MA-M8-5.1.2 Students will represent, analyze, and generalize functions with tables, graphs, words, and algebraic expressions, and will use the functions to solve real-world and/or mathematical problems.</p>	G. Graph a variety of equations and inequalities in two variables, demonstrate understanding of the relationships between the algebraic properties of an equation and the geometric properties of its graph, and interpret a graph:

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	<b>J4.1. Graph a linear equation</b> and demonstrate that it has a constant rate of change.	<p>M-8-A-10 Students will graph linear functions in a four quadrant (Cartesian) system/grid and interpret the results.</p> <p>M-8-A-11 Students will determine the slope and equation of a line by analyzing the line (e.g., <math>Y = mx + b</math>; <math>m</math> is rise/run, <math>b</math> is <math>y</math> - intercept).</p>	<p><b>MA-H11-1.4.1</b> Students will use ratios and proportional reasoning to solve real-world and/or mathematical problems (e.g., those involving slope and rate) and will explain how slope shows a rate of change in linear functions representing real-world problems.</p>	Graph a linear equation and demonstrate that it has a constant rate of change.
	<b>J4.2.</b> Understand the relationship between the coefficients of a <b>linear equation</b> and the slope and $x$ - and $y$ -intercepts of its graph.	<p>M-H-A-4 Students will use characteristics of the graphs of linear functions, such as slope and intercepts, transformations.</p> <p>M-8-A-11 Students will determine the slope and equation of a line by analyzing the line (e.g., <math>Y = mx + b</math>; <math>m</math> is rise/run, <math>b</math> is <math>y</math> - intercept).</p>	<p><b>MA-H11-5.1.2</b> Students will find the slope and intercepts of a linear function;</p> <p><b>MA-H11-5.3.2</b> Students will write and/or solve first degree, two-variable equations and inequalities in real-world and/or mathematical situations, and will graph the solutions on a coordinate plane.</p>	Understand the relationship between the coefficients of a <b>linear equation</b> and the slope and $x$ - and $y$ -intercepts of its graph
	<b>J4.3.</b> Understand the relationship between a solution of a <b>system of two linear equations</b> in two variables and the graphs of the corresponding lines.		<b>MA-H11-5.3.3</b> Students will write and graph systems of linear equations (two equations in two variables), use the system to solve and interpret real-world and/or mathematical problems.	Understand the relationship between a solution of a <b>system of two linear equations</b> in two variables and the graphs of the corresponding lines.

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	J4.4. Graph the solution set of a <b>linear inequality</b> and identify whether the solution set is an open or a closed half-plane; graph the solution set of a system of two or three linear inequalities.	M-8-A-6 <i>Students will investigate inequalities using a variety of methods and representations</i>	MA-H11-5.3.2  Students will write and/or solve first degree, two-variable equations and inequalities in real-world and/or mathematical situations, and will graph the solutions on a coordinate plane.  <i>MA-H11-5.3.3a Students will write, graph, and solve systems of linear inequalities (two inequalities in two variables) based on real world or mathematical situations and interpret the solution.</i>	Graph the solution set of a <b>linear inequality</b>
	J4.5. Graph a <b>quadratic</b> function and understand the relationship between its real zeros and the x-intercepts of its graph.	M-H-A-8 Students will use the skills learned to solve linear equations and inequalities to solve numerically, <b>graphically</b> , or symbolically non-linear equations such as quadratic and exponential equations.  M-H-A-10 Students will extend ideas of transformations of linear equations, such as vertical and horizontal shifts, to <b>transformations of nonlinear equations</b> .	MA-H11-5.1.2 Students will find the maximum, minimum, and intercepts of a quadratic function	Graph a <b>quadratic</b> function and understand the relationship between its real zeros and the x-intercepts of its graph.

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	J4.6. * Graph <b>ellipses and hyperbolas</b> whose axes are parallel to the x and y axes and demonstrate understanding of the relationship between their standard algebraic form and their graphical characteristics.			Graph <b>ellipses and hyperbolas</b> whose axes are parallel to the x and y axes and demonstrate understanding of the relationship between their standard algebraic form and their graphical characteristics.
	J4.7. Graph <b>exponential</b> functions and identify their key characteristics.	M-H-A-8 Students will use the skills learned to solve linear equations and inequalities to solve numerically, <b>graphically</b> , or symbolically non-linear equations such as quadratic and <b>exponential equations</b> .	<b>MA-H11-5.1.1</b> <b>Students will identify and use multiple representations (tables, graphs, equations) of functions (linear, quadratic, absolute value, exponential) to solve real-world and/or mathematical problems.</b>	Graph <b>exponential</b> functions and identify their key characteristics.
	J4.8. Read information and draw conclusions from graphs; identify properties of a graph that provide useful information about the original problem.	M-H-A-3 Students will write and solve linear sentences, describing real-world situations by using and relating formulas, tables, graphs, and equations.		Read information and draw conclusions from graphs; identify properties of a graph that provide useful information about the original problem.

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Solving problems algebraically	J5. Solve problems by converting the verbal information given into an appropriate mathematical model involving equations or systems of equations; apply appropriate mathematical techniques to analyze these mathematical models; and interpret the solution obtained in written form using appropriate units of measurement:			H. Solve problems by converting the verbal information given into an appropriate mathematical model involving equations or systems of equations; apply appropriate mathematical techniques to analyze these mathematical models; and interpret the solution obtained in written form using appropriate units of measurement:
	J5.1. Recognize and solve problems that can be modeled using a <b>linear</b> equation in one variable, such as time/rate/distance problems, percentage increase or decrease problems, and ratio and proportion problems.	M-H-A-3 Students will write and solve linear sentences, describing real-world situations by using and relating formulas, tables, graphs, and equations.	<b>MA-H11-1.4.1</b> <b>Students will use ratios and proportional reasoning to solve real-world and/or mathematical problems (e.g., those involving slope and rate) and will explain how slope shows a rate of change in linear functions representing real-world problems.</b>	Recognize and solve problems that can be modeled using a <b>linear</b> equation in one variable, such as time/rate/distance problems, percentage increase or decrease problems, and ratio and proportion problems.

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	<b>J5.2.</b> Recognize and solve problems that can be modeled using a <b>system of two equations</b> in two variables, such as mixture problems.		<b>MA-H11-5.3.3</b> <b>Students will write and graph systems of linear equations (two equations in two variables), use the system to solve and interpret real-world and/or mathematical problems.</b>	Recognize and solve problems that can be modeled using a <b>system of two equations</b> in two variables
	<b>J5.3.</b> Recognize and solve problems that can be modeled using a <b>quadratic equation</b> , such as the motion of an object under the force of gravity.		<b>MA-H11-5.3.4</b> <b>Students will solve quadratic equations from real world or mathematical situations.</b>	Recognize and solve problems that can be modeled using a <b>quadratic equation</b> , such as the motion of an object under the force of gravity.
	<b>J5.4.</b> Recognize and solve problems that can be modeled using an <b>exponential function</b> , such as compound interest problems.		<b>MA-H11-5.1.1</b> <b>Students will identify and use multiple representations (tables, graphs, equations) of functions (linear, quadratic, absolute value, exponential) to solve real-world and/or mathematical problems.</b>	Recognize and solve problems that can be modeled using an <b>exponential function</b> , such as compound interest problems.

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	J5.5. * Recognize and solve problems that can be modeled using an <b>exponential function</b> but whose solution requires facility with logarithms, such as exponential growth and decay problems.			Recognize and solve problems that can be modeled using an <b>exponential function</b> but whose solution requires facility with logarithms, such as exponential growth and decay problems.
	J5.6. Recognize and solve problems that can be modeled using a <b>finite geometric series</b> , such as home mortgage problems and other compound interest problems.			.Recognize and solve problems that can be modeled using a <b>finite geometric series</b> , such as home mortgage problems and other compound interest problems.
Patterns and Sequences		M-H-A-14 Students will see the patterns in arithmetic sequences and geometric sequences using recursion (formulas expressing each term as a function of one or more of the previous terms).  M-H-A-15 Students will see patterns in other sequences (e.g., quadratic, cubic).  M-H-A-16 Students will relate the patterns in	MA-H11-1.3.2 <b>Students will recognize, describe, or extend arithmetic and geometric sequences; will determine a specific term of a sequence given an explicit formula; will write an explicit rule for the nth term of an arithmetic sequence; and will use sequences to solve real-world and/or mathematical problems.</b>	



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		<p>arithmetic sequences to linear equations.</p> <p>M-H-A-17 Students will relate the patterns in geometric sequences to exponential equations (e.g., squared, cubed, nth power).</p>	<p><i>MA-H11-1.3.2a Students will write an explicit rule for the <math>n</math>th term of a geometric sequence.</i></p> <p><i>MA-M8-5.1.1a Students will use variables to describe numerical patterns based on arithmetic sequences in real world and/or mathematical situations (i.e. <math>f(N)=2N+3</math>).</i></p> <p><i>MA-M8-5.1.2a Students will write equations for arithmetic (linear) sequences (nth term).</i></p>	
1.8.1 Elementary Analysis (sequences, series, binomial theorem, limits and continuity)	J6. * Understand the binomial theorem and its connections to combinatorics, Pascal's triangle and probability.			Understand the binomial theorem and its connections to combinatorics, Pascal's triangle and probability.

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	<b>J1.7.</b> * Derive and use the formulas for the general term and summation of finite arithmetic and geometric series; find the sum of an infinite geometric series whose common ratio, $r$ , is in the interval $(-1, 1)$ .			Derive and use the formulas for the general term and summation of finite arithmetic and geometric series and infinite geometric series with common ratio, $r$ , in the interval $(-1, 1)$ .
<b>1.3 Geometry: Position Visualization &amp; Shape</b>	<b>K. Geometry</b> The high school graduate can:			<b>GEOMETRY</b>
<b>1.9.1 Validation &amp; Justification (axiom systems and proof)</b>	<b>K1.</b> Understand the different roles played by axioms, definitions and theorems in the logical structure of mathematics, especially in geometry:			<b>I.</b> Understand the different roles played by axioms, definitions and theorems in the logical structure of mathematics, especially in geometry:
	<b>K1.1.</b> Identify, explain the necessity of and give examples of definitions, axioms and theorems.			Identify, explain the necessity of and give examples of definitions, axioms and theorems

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	K1.2. State and <b>prove</b> key basic theorems in geometry such as the Pythagorean theorem, the sum of the angles of a triangle is 180 degrees, and the line joining the midpoints of two sides of a triangle is parallel to the third side and half its length.	M-8-GM-1 <i>Students will discover and apply the Pythagorean theorem.</i>  M-6-GM-6 <i>Students will formulate the rule that the sum of angle measurements is 180 degrees in a triangle and 360 degrees in a quadrilateral.</i>		State and <b>USE</b> key basic theorems in geometry such as the Pythagorean theorem, the sum of the angles of a triangle is 180 degrees, and the line joining the midpoints of two sides of a triangle is parallel to the third side and half its length.  <b>Prove</b> key basic theorems in geometry such as the Pythagorean theorem, the sum of the angles of a triangle is 180 degrees, and the line joining the midpoints of two sides of a triangle is parallel to the third side and half its length.
	K1.3. Recognize that there are geometries, other than Euclidean geometry, in which the parallel postulate is not true.			
1.3.2 2-D Geometry (including constructions)	K2. Identify and apply the definitions related to lines and angles and use them to prove theorems in (Euclidean) geometry, solve problems, and perform basic geometric constructions using a straight edge and compass:	M-H-G-1 Students will find angle relationships such as vertical angles, linear pairs, complementary angles, and supplementary angles.  M-H-G-2 Students will identify relationships between and among points, lines, and planes, such as betweenness of points, midpoint, distance, collinear, coplanar, parallel, and skew lines.	MA-H11-3.1.1 <b>Students will describe, analyze, and apply spatial relationships (not using Cartesian coordinates) among points, lines, and planes (e.g., betweenness of points, midpoint, segment length, collinear, coplanar, parallel, perpendicular, skew).</b>	J. Identify and apply the definitions AND PROPERTIES related to lines and angles and use them TO solve problems

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		<p>M-H-G-3 Students will find the intersection of lines, planes, and solids.</p> <p>M-H-G-5 Students will integrate constructions such as segments and angles, segment bisectors, perpendiculars, angle bisectors, parallel lines, circles, arcs, and polygons.</p> <p>M-H-G-6 Students will describe, draw, and construct two-dimensional and three-dimensional figures.</p>	<p><i>MA-M8-3.1.1a Students will describe and give examples of, basic geometric elements that include points, segments, rays, lines, angles, and planes, and will use these elements in real-world and/or mathematical situations.</i></p>	
	<p><b>K2.1.</b> Identify and apply properties of and theorems about <b>parallel lines</b> and use them to prove theorems such as two lines parallel to a third are parallel to each other and to perform constructions such as a line parallel to a given line through a point not on the line.</p>	<p>M-H-G-2 Students will identify relationships between and among points, lines, and planes, such as betweenness of points, midpoint, distance, collinear, coplanar, <b>parallel</b>, and skew lines.</p> <p>M-H-G-5 Students will integrate constructions such as segments and angles, segment bisectors, perpendiculars, angle bisectors, <b>parallel lines</b>, circles, arcs, and polygons.</p>	<p><b>MA-H11-3.1.1</b> <b>Students will describe, analyze, and apply spatial relationships (not using Cartesian coordinates) among points, lines, and planes (e.g., betweenness of points, midpoint, segment length, collinear, coplanar, parallel, perpendicular, skew).</b></p>	<p>Identify and apply properties of and theorems about <b>parallel lines</b></p>

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	<b>K2.2.</b> Identify and apply properties of and theorems about <b>perpendicular lines</b> and use them to prove theorems such as the perpendicular bisectors of line segments are the set of all points equidistant from the two end points and to perform constructions such as the perpendicular bisector of a line segment.	M-H-G-5 Students will integrate constructions such as segments and angles, segment bisectors, <b>perpendiculars</b> , angle bisectors, parallel lines, circles, arcs, and polygons.	<b>MA-H11-3.1.1</b> <b>Students will describe, analyze, and apply spatial relationships (not using Cartesian coordinates) among points, lines, and planes (e.g., betweenness of points, midpoint, segment length, collinear, coplanar, parallel, perpendicular, skew).</b>	Identify and apply properties of and theorems about <b>perpendicular lines</b>
	<b>K2.3.</b> Identify and apply properties of and theorems about <b>angles</b> and use them to prove theorems such as two lines are parallel exactly when the alternate interior angles they make with a transversal are equal and to perform constructions such as the bisector of an angle	M-H-G-5 Students will integrate constructions such as segments and <b>angles</b> , segment bisectors, perpendiculars, <b>angle bisectors</b> , parallel lines, circles, arcs, and polygons.  M-H-G-1 Students will find <b>angle relationships</b> such as vertical angles, linear pairs, complementary angles, and supplementary angles	<b>MA-H11-3.1.2</b> <b>Students will describe, analyze, and apply angle relationships (e.g., linear pairs, vertical, complementary, supplementary, corresponding, and alternate interior angles) in real-world and/or mathematical situations.</b>	Identify and apply properties of and theorems about <b>angles</b>

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1.4.2 Congruence And Similarity (proportionality concepts and problems based on similarity and scale)	K3. Know the basic theorems about congruent and similar triangles and use them to prove additional theorems and solve problems.	M-H-G-14 Students will prove triangles and other polygons congruent and similar, and explore corresponding parts relationships  M-H-G-23 Students will use the relationship between a figure and its image under a transformation (congruence, similarity, size, and scale changes).	MA-H11-3.1.6  Students will apply the concepts of congruence and similarity to solve real-world and/or mathematical problems (not including proofs).  MA-M8-3.1.4 Students will describe and give examples of congruent and similar figures; will use congruent and similar figures to solve real-world and/or mathematical problems, and will use proportional reasoning to solve problems involving scale drawings and similar figures.	K. UNDERSTAND the basic theorems about congruent and similar triangles and use them to solve problems.  PROVE the basic theorems about congruent and similar triangles (deepened skill)
	K7. Know about the similarity of figures and use the scale factor to solve problems.	M-H-G-23 Students will use the relationship between a figure and its image under a transformation (congruence, similarity, size, and scale changes). M-H-G-15 Students will use proportional reasoning to solve real-world problems, to do indirect measurements, and to make scale drawings.	MA-M8-3.1.4 Students will describe and give examples of congruent and similar figures; will use congruent and similar figures to solve real-world and/or mathematical problems, and will use proportional reasoning to solve problems involving scale drawings and similar figures.	N. USE THE CONCEPT OF similarity of figures to solve problems.

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1.3.3 2-D Geometry: Circles	<b>K4. Know the definitions and basic properties of a circle and use them to prove basic theorems and solve problems.</b>	M-H-G-5 Students will integrate constructions such as segments and angles, segment bisectors, perpendiculars, angle bisectors, parallel lines, <b>circles, arcs</b> , and polygons.  M-H-G-12 Students will use properties of circles, arcs, chords, central angles, inscribed angles, and concentric circles	<b>MA-M8-3.1.2</b> <b>Students will compare and contrast properties of two-dimensional shapes (circles, triangles acute, right, obtuse, scalene, isosceles, equilateral), quadrilaterals [square, rectangles, rhombus, parallelogram, trapezoid], regular/irregular polygons), and will use these properties and shapes to solve real-world and/or mathematical problems.</b>	<b>L. UNDERSTAND THE definitions and basic properties of a circle and use them to solve problems.</b>  <b>PROVE BASIC THEOREMS ABOUT CIRCLES (deepened skill)</b>
1.3.3 2-D Geometry: Polygons (including Pythagorean theorem)	<b>K5. Apply the Pythagorean theorem, its converse and properties of special right triangles to solve problems.</b>	M-H-G-5 Students will integrate constructions such as segments and angles, segment bisectors, perpendiculars, angle bisectors, parallel lines, circles, arcs, and <b>polygons.</b>  M-H-G-6 Students will describe, draw, and construct two-dimensional and three-dimensional figures.	<b>MA-H11-2.1.3 Students will use definitions and properties of right triangle relationships (right triangle trigonometry and the Pythagorean theorem) to determine length and angle measures to solve real-world and/or mathematical problems.</b>	<b>M. Apply the Pythagorean theorem, its converse and properties of special right triangles to solve problems.</b>

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		<p>M-H-G-7 Students will use angle and side relationships such as triangle sum theorem, triangle inequalities, isosceles and equilateral triangle properties, altitude, and median.</p> <p><b>M-H-G-8 Students will use Pythagorean theorem and its converse.</b></p> <p>M-H-G-10 Students will use properties of quadrilaterals such as classification.</p> <p>M-H-G-11 Students will use properties of other polygons.</p> <p>M-H-G-13 Students will use inscribed and circumscribed polygons.</p>	<p><b>MA-H11-3.1.3 Students will classify and apply properties of two-dimensional geometric figures (e.g., number of sides, vertices, length of sides, sum of interior and exterior angle measures).</b></p> <p><b>MA-H11-3.1.4</b> <b>Students will use properties of triangles (e.g., Triangle Sum theorem and Isosceles Triangle theorems) to solve problems in real-world and/or mathematical situations.</b></p> <p><b>MA-M8-2.1.4</b> <b>Students will use the Pythagorean theorem to find the hypotenuse of a right triangle.</b></p>	
1.4.1 Geometry: Transformations	<b>K6. Use rigid motions (compositions of reflections, translations and rotations) to determine whether two geometric figures are congruent and to create and analyze geometric designs.</b>	<p>M-H-G-21 Students will use reflections, translations, rotations, and dilations.</p> <p>M-H-G-23 Students will use the relationship between a figure and its image under a transformation (congruence, similarity, size, and scale changes)</p>	<p><b>MA-H11-3.2.1</b> Students will describe properties, and apply geometric transformations (with and without a coordinate plane) to real-world and/or mathematical situations.</p>	<b>Use rigid motions (compositions of reflections, translations and rotations) to determine whether two geometric figures are congruent and to create and analyze geometric designs.</b>



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		M-8-GM-5 Students will investigate transformations' congruence, proportionality, and similarity (e.g., enlargements, reductions, proportional triangles) in a coordinate plane.	<b>MA-M8-3.2.2</b> <b>Students will translate, reflect, and dilate (with the center of dilation at the origin) shapes in a coordinate plane and determine new coordinates of the shape after the transformation.</b>	
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1.2.1 Measurement Units (metric & customary, tools & dimensional analysis)	K8. Know that geometric measurements (length, area, perimeter, volume) depend on the choice of a unit and that measurements made on physical objects are approximations; calculate the measurements of common plane and solid geometric figures:	M-H-G-16 Students will use relationships among one-, two-, and three- dimensional measures. M-H-G-18 Students will convert from one measure to another within the same system. M-6-GM-4 Students will estimate, compare, and convert units of measures for length, weight/mass, and volume/capacity within the U.S. customary system and within the metric system: a) <b>length</b> (e.g., parts of an inch, inches, feet, yards, miles, millimeter, centimeter, kilometer); b) <b>weight/mass</b> (e.g., pounds, tons, grams, kilograms); and c) <b>volume</b> /capacity (e.g., cups, pints, quarts, gallons, milliliters, liters). (The intent of this standard is for students to make ballpark comparisons and not to memorize conversion factors between U.S. and metric units.)	Students continue to measure and estimate measurements including fractions and decimals. They use formulas to find perimeter, area, circumference and volume. They use rulers and protractors. They use US Customary and metric units of measurement.	O. Know that geometric measurements (length, area, perimeter, volume) depend on the choice of a unit and that measurements made on physical objects are approximations; calculate the measurements of common plane and solid geometric figures:

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	<p><b>K8.1.</b> Understand that numerical values associated with measurements of physical quantities must be assigned units of measurement or dimensions; apply such units correctly in expressions, equations and problem solutions that involve measurements; and convert a measurement using one unit of measurement to another unit of measurement.</p>	<p>M-H-G-18 Students will convert from one measure to another within the same system.</p> <p>M-6-GM-4 Students will estimate, compare, and convert units of measures for length, weight/mass, and volume/capacity within the U.S. customary system and within the metric system: a) <b>length</b> (e.g., parts of an inch, inches, feet, yards, miles, millimeter, centimeter, kilometer); b) <b>weight/mass</b> (e.g., pounds, tons, grams, kilograms); and c) <b>volume/capacity</b> (e.g., cups, pints, quarts, gallons, milliliters, liters). (The intent of this standard is for students to make ballpark comparisons and not to memorize conversion factors between U.S. and metric units.)</p>	<p>MA-H11-2.2.1a <b>Students will continue to apply to both real world and mathematical situations U.S. customary and metric systems of measurement.</b></p> <p>MA-M8-2.2.1 <b>Students will describe and give examples of U.S. Customary and metric units of measurement and use these units to solve real-world and/or mathematical problems.</b></p>	<p>Understand that numerical values associated with measurements of physical quantities must be assigned units of measurement or dimensions; apply such units correctly in expressions, equations and problem solutions that involve measurements; and convert a measurement using one unit of measurement to another unit of measurement.</p>
1.2.3 Estimation & Error (precision & accuracy)				

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1.2.2 Computations & properties of Length, Perimeter, Area, Surface Area & Volume	K8.2. Determine the perimeter of a polygon and the circumference of a circle; the area of a rectangle, a circle, a triangle and a polygon with more than four sides by decomposing it into triangles; the surface area of a prism, a pyramid, a cone and a sphere; and the volume of a rectangular box, a prism, a pyramid, a cone and a sphere.	<p>M-H-G-17 Students will use perimeter, circumference, and area of planar regions to determine volume and surface area of solids.</p> <p>M-8-GM-3 Students will develop and apply formulas for volume and surface area of cubes, cylinders, and rectangular prisms; and investigate relationships between and among them.</p> <p>M-7-GM-2 Students will develop and use the formulas for area of triangles, parallelograms, and trapezoid; relate to the formula for area of rectangles (<math>1 \times w</math>).</p> <p>M-7-GM-4 Students will investigate area of polygons and other two-dimensional shapes.</p>	<p>MA-H11-2.1.1 Students will find, when given the formulas, the surface area and volume of rectangular prisms, pyramids, cylinders, cones, and spheres in real-world and/or mathematical situations.</p> <p>MA-M8-2.1.1 Students will find measures of both regular and irregular shapes, including lengths to the nearest sixteenth of an inch or the nearest millimeter, will find the area and perimeter of triangles and quadrilaterals, and will find the area and circumference of circles.</p> <p>MA-M8-2.1.1b <i>Students will explain how measurements and measurement formulas are related or different (perimeter and area; rate, time, and distance; circumference and area of a circle).</i></p>	Determine the perimeter of a polygon and the circumference of a circle; the area of a rectangle, a circle, a triangle and a polygon with more than four sides by decomposing it into triangles; the surface area of a prism, a pyramid, a cone and a sphere; and the volume of a rectangular box, a prism, a pyramid, a cone and a sphere.
	K8.3. Know that the effect of a scale factor $k$ on length, area and volume is to multiply each by $k$ , $k^2$ and $k^3$ , respectively.		MA-H11-2.1.2 Students will describe how a change in one or more dimensions of a geometric shape affects the perimeter, area, and volume of the shape.	Know that the effect of a scale factor $k$ on length, area and volume is to multiply each by $k$ , $k^2$ and $k^3$ , respectively.

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1.3.4 3-D Geometry	<b>K9. Visualize solids and surfaces in three-dimensional space when given two-dimensional representations (e.g., nets, multiple views) and create two-dimensional representations for the surfaces of three-dimensional objects.</b>	<p>M-H-G-3 Students will find the intersection of lines, planes, and solids.</p> <p>M-H-G-6 Students will describe, draw, and construct two-dimensional and three-dimensional figures.</p> <p><b>M-7-GM-7</b> Students will represent three-dimensional geometric figures with special attention to developing spatial sense (e.g., top view, side view, three-dimensional shapes drawn on isometric dot paper).</p>	<p><b>MA-H11-3.1.5</b> <b>Students will classify and apply properties of three-dimensional geometric figures (e.g., number of edges, faces, vertices).</b></p> <p><i>MA-H11-3.1.5a Students will describe the intersection of a plane with a three-dimensional figure</i></p> <p><b>MA-M8-3.1.3</b> <b>Students will compare and contrast properties of three-dimensional shapes (spheres, cones, cylinders, prisms, pyramids), and will use these properties and shapes to solve real-world and/or mathematical problems.</b></p>	<b>Visualize solids and surfaces in three-dimensional space when given two-dimensional representations (e.g., nets, multiple views) and create two-dimensional representations for the surfaces of three-dimensional objects.</b>
1.3.1 1-D & 2-D Coordinate Geometry (including conic sections)	<b>K10. Represent geometric objects and figures algebraically using coordinates; use algebra to solve geometric problems:</b>	<p>M-H-G-4 Students will connect geometric diagrams with algebraic representations.</p> <p>M-H-G-19 Students will represent geometric figures and properties using coordinates.</p>	<p><b>MA-M8-3.2.2</b> <b>Students will translate, reflect, and dilate (with the center of dilation at the origin) shapes in a coordinate plane and determine new coordinates of the shape after the transformation.</b></p> <p><i>MA-M8-3.2.2a Students will rotate (clockwise or counterclockwise) about the origin, shapes in a coordinate plane</i></p>	<b>Represent geometric objects and figures algebraically using coordinates; use algebra to solve geometric problems:</b>

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	<b>K10.1.</b> Express the intuitive concept of the “slant” of a line in terms of the precise concept of slope, use the coordinates of two points on a line to define its slope, and use slope to express the parallelism and perpendicularity of lines.	M-H-A-4 Students will use characteristics of the graphs of linear functions, such as slope and intercepts, transformations.  M-H-G-20 Students will connect the concepts of slope, distance, and midpoint to coordinate geometry.	<b>MA-H11-3.3.1</b> <b>Students will use algebra and the coordinate plane to analyze and solve problems (e.g., finding the final coordinates for a specified polygon, finding midpoints, finding the distance between two points, finding the slope of a segment).</b>	Express the intuitive concept of the “slant” of a line in terms of the precise concept of slope, use the coordinates of two points on a line to define its slope, and use slope to express the parallelism and perpendicularity of lines.
	<b>K10.2.</b> Describe a line by a linear equation.			Describe a line by a linear equation.
	<b>K10.3.</b> Find the distance between two points using their coordinates and the Pythagorean theorem.	M-H-G-20 Students will connect the concepts of slope, distance, and midpoint to coordinate geometry.	<b>MA-H11-3.3.1</b> <b>Students will use algebra and the coordinate plane to analyze and solve problems (e.g., finding the final coordinates for a specified polygon, finding midpoints, finding the distance between two points, finding the slope of a segment).</b>	Find the distance between two points using their coordinates and the Pythagorean theorem.
	<b>K10.4. * Find</b> an equation of a circle given its center and radius and, given an equation of a circle, find its center and radius.			<b>Find</b> an equation of a circle given its center and radius  <b>Given an equation of a circle, find its center and radius</b>

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<b>Vectors</b>		M-H-G-22 Students will explore concepts of vectors		
<b>1.5.3 Trigonometry - Trigonometric Functions</b>	<b>K11. Understand basic right- triangle trigonometry and apply it to solve problems:</b>	M-H-G-9 Students will use right triangle relationships such as trigonometric ratios (45-45-90 and 30-60-90 triangles).		<b>Understand basic right-triangle trigonometry and apply it to solve problems:</b>
	<b>K11.1.</b> Understand how similarity of right triangles allows the trigonometric functions sine, cosine and tangent to be defined as ratios of sides and be able to use these functions to solve problems.		<b>MA-H11-2.1.3 Students will use definitions and properties of right triangle relationships (right triangle trigonometry and the Pythagorean theorem) to determine length and angle measures to solve real-world and/or mathematical problems.</b>	Understand how similarity of right triangles allows the trigonometric functions sine, cosine and tangent to be defined as ratios of sides and be able to use these functions to solve problems
	<b>K11.2.</b> Apply the trigonometric functions sine, cosine and tangent to solve for an unknown length of a side of a right triangle, given one of the acute angles and the length of another side.		<b>MA-H11-2.1.3 Students will use definitions and properties of right triangle relationships (right triangle trigonometry and the Pythagorean theorem) to determine length and angle measures to solve real-world and/or mathematical problems.</b>	Apply the trigonometric functions sine, cosine and tangent to solve for an unknown length of a side of a right triangle, given one of the acute angles and the length of another side.

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	<p><b>K11.3.</b> Use the standard formula for the area of a triangle, <math>A = \frac{1}{2}bh</math>, to explain the area formula, <math>A = \frac{1}{2}ab\sin C</math> where a and b are the lengths of two sides of a triangle and C is the measure of the included angle formed by these two sides, and use it to find the area of a triangle when given the lengths of two of its sides and the included angle.</p>			
	<p><b>K12. *</b> Know how the trigonometric functions can be extended to periodic functions on the real line, derive basic formulas involving these functions, and use these functions and formulas to solve problems:</p>			<p>Know how the trigonometric functions can be extended to periodic functions on the real line, derive basic formulas involving these functions, and use these functions and formulas to solve problems:</p>



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	<b>K12.1.</b> * Know that the trigonometric functions sine and cosine, and thus all trigonometric functions, can be extended to periodic functions on the real line by defining them as functions on the unit circle, that radian measure of an angle between 0 and 360 degrees is the arc length of the unit circle subtended by that central angle, and that by similarity, the arc length $s$ of a circle of radius $r$ subtended by a central angle of measure $t$ radians is $s = rt$ .			Know that the trigonometric functions sine and cosine, and thus all trigonometric functions, can be extended to periodic functions on the real line by defining them as functions on the unit circle, that radian measure of an angle between 0 and 360 degrees is the arc length of the unit circle subtended by that central angle, and that by similarity, the arc length $s$ of a circle of radius $r$ subtended by a central angle of measure $t$ radians is $s = rt$ .
	<b>K12.2.</b> * <b>Know</b> and use the basic identities, such as $\sin^2(x) + \cos^2(x) = 1$ and $\cos(\pi/2 - x) = \sin(x)$ and formulas for sine and cosine, such as addition and double angle formulas.			<b>Know</b> and use the basic identities, such as $\sin^2(x) + \cos^2(x) = 1$ and $\cos(\pi/2 - x) = \sin(x)$ and formulas for sine and cosine, such as addition and double angle formulas.
	<b>K12.3.</b> * <b>Graph</b> sine, cosine and tangent as well as their reciprocals, secant, cosecant and cotangent; identify key characteristics.			<b>Graph</b> sine, cosine and tangent as well as their reciprocals, secant, cosecant and cotangent; identify key characteristics.

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	<b>K12.4. * Know</b> and use the law of cosines and the law of sines to find missing sides and angles of a triangle.			<b>Know</b> and use the law of cosines and the law of sines to find missing sides and angles of a triangle.
<b>1.7.1 Data Representation &amp; Analysis</b>	<b>L. Data Interpretation, Statistics and Probability</b> - The high school graduate can:		School students extend data representations, interpretations and conclusions. They describe data distributions in multiple ways and connect data gathering issues with data interpretation issues. They relate curve of best fit with two-variable data and determine line of best fit for a given set of data. They distinguish between combinations and permutations and compare and contrast theoretical and experimental probability.	<b>DATA/STATISTICS/ PROBABILITY</b>
	<b>L1. Explain and apply quantitative information:</b>			<b>R. Explain and apply quantitative information:</b>
Organize & Display Data	<b>L1.1.</b> Organize and display data using appropriate methods (including spreadsheets) to detect patterns and departures from patterns.	<b>M-8-PS-1</b> Students will collect, organize, analyze, and interpret data in a variety of graphical methods (e.g., circle graphs, scatter plots, box and whisker plots, histograms).  <b>M-7-PS-1</b> Students will collect, organize, analyze, and interpret data in a variety of graphical methods, including circle graphs, multiple line graphs, double bar graphs, and double stem and leaf plots.	<b>MA-H11-4.1.2</b> Students will organize and construct data displays for data with no more than two variables  <b>MA-M8-4.1.2</b> Students will organize and construct data displays (pictographs, bar graphs, line plots, Venn diagrams, tables, line graphs, stem-and-leaf plots, circle graphs, scatter plots, box-	Organize and display data using appropriate methods (including spreadsheets) to detect patterns and departures from patterns.

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		<p>M-8-PS-3 Students will select an appropriate graph to represent given data and justify its use.</p>	<p>and-whiskers plots), will explain why the type of display is appropriate for the data, and will explain how misleading representations affect interpretations and conclusions about data (e.g., changing the scale on a graph).</p>	
Read & Interpret	L1.2. Read and interpret tables, charts and graphs.	<p>M-8-PS-2 Students will make predictions, <b>draw conclusions</b>, and verify results from statistical data and probability experiments.</p> <p>M-8-PS-4 Students will <b>compare data</b> from various types of graphs.</p> <p>M-8-PS-5 Students will recognize that statistics can be <b>interpreted</b> in many ways.</p> <p>M-8-PS-1 Students will collect, organize, analyze, and <b>interpret data</b> in a variety of graphical methods (e.g., circle graphs, scatter plots, box and whisker plots, histograms).</p> <p>M-7-PS-1 Students will collect, organize, analyze, and <b>interpret data</b> in a variety of graphical methods, including circle graphs, multiple line</p>	<p><b>MA-H11-4.1.1</b>  Students will read/interpret, analyze, and make inferences from a set of data with no more than two variables, and will analyze situations for the use and misuse of data representations.</p> <p><b>MA-M8-4.1.1</b> Students will read/interpret, analyze, and make inferences from data displays (drawings, tables/charts, pictographs, bar graphs, circle graphs, line plots, Venn diagrams, line graphs, stem-and-leaf plots, scatter plots, histograms, box-and-whiskers plots).</p>	Read and interpret tables, charts and graphs.

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		graphs, double bar graphs, and double stem and leaf plots.		
Summary Statistics	<b>L1.3.</b> Compute and explain summary statistics for distributions of data including measures of center (mean, median) and spread (range, percentiles, variance, standard deviation).	<p><b>M-7-PS-7</b> Students will determine and apply the most appropriate measures of central tendency (e.g., mean, median, mode) and/or dispersion (e.g., range).</p> <p><b>M-8-PS-12</b> Students will determine and interpret clusters, quartiles, gaps, and outliers in data.</p>	<p><b>MA-H11-4.2.1</b> <b>Students will use shapes of graphs, measures of center (mean, median, mode), and measures of spread (range, standard deviation) to describe data distributions and to draw conclusions.</b></p> <p><b>MA-M8-4.2.1</b> <b>Students will determine the mean, median, mode, and range of a set of data, will recognize clusters, gaps, and outliers within the data, and will use these concepts to compare sets of data.</b></p>	Compute and explain summary statistics for distributions of data including measures of center (mean, median) and spread (range, percentiles, variance, standard deviation).
	<b>L1.4.</b> Compare data sets using graphs and summary statistics.	<p><b>M-8-PS-4</b> Students will <b>compare data</b> from various types of graphs.</p>		Compare data sets using graphs and summary statistics.

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	<b>L1.5.</b> Create scatter plots, analyze patterns and describe relationships in paired data.	<b>M-8-PS-1</b> Students will collect, organize, analyze, and <b>interpret data</b> in a variety of graphical methods (e.g., circle graphs, <b>scatter plots</b> , box and whisker plots, histograms).		Create scatter plots, analyze patterns and describe relationships in paired data.
Normal distribution	<b>L1.6.</b> Know the characteristics of the Gaussian normal distribution (bell shaped curve).			Know the characteristics of the Gaussian normal distribution (bell shaped curve).
Critique	<b>L2. Explain and critique alternative ways of presenting and using information:</b>			<b>Explain and critique alternative ways of presenting and using information:</b>
	<b>L2.1.</b> Evaluate reports based on data published in the media by considering the source of the data, the design of the study, and the way the data are analyzed and displayed.			Evaluate reports based on data published in the media by considering the source of the data, the design of the study, and the way the data are analyzed and displayed.

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Misuse of Data	<b>L2.2.</b> Identify and explain misleading uses of data.		<b>MA-H11-4.1.1</b>  Students will read/interpret, analyze, and make inferences from a set of data with no more than two variables, and will analyze situations for the use and misuse of data representations.  <i>MA-M8-4.3.1a</i> <i>Students will explain how data gathering, bias issues, and faulty data analysis, can affect the results of data collection</i>	Identify and explain misleading uses of data.
	<b>L2.3.</b> Recognize when arguments based on data confuse correlation with causation.			Recognize when arguments based on data confuse correlation with causation.
Prediction & Inferences	<b>L3. Explain the use of data and statistical thinking to draw inferences, make predictions and justify conclusions:</b>	<i>M-7-PS-2</i> <i>Students will make predictions, draw conclusions, and verify results from statistical data and probability experiments.</i>		<b>Explain the use of data and statistical thinking to draw inferences, make predictions and justify conclusions:</b>
Sampling & Bias	<b>L3.1.</b> Explain the impact of sampling methods, bias and the phrasing of questions asked during data collection and the conclusions that can rightfully be made.		<b>MA-H11-4.3.1</b> Students will explain how data gathering (e.g., polling only a specific group of people, using limited or extremely small sample sizes, bias issues) can lead to inaccurate inferences.	Explain the impact of sampling methods, bias and the phrasing of questions asked during data collection and the conclusions that can rightfully be made.

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	<b>L3.2.</b> Design simple experiments or investigations to collect data to answer questions of interest.			Design simple experiments or investigations to collect data to answer questions of interest.
	<b>L3.3.</b> Explain the differences between randomized experiments and observational studies.	<i>M-7-PS-10</i> <i>Students will explore concepts of randomness and independent events.</i>		Explain the differences between randomized experiments and observational studies.
Curve Fitting	<b>L3.4.</b> Construct a scatter plot of a set of paired data, and if it demonstrates a linear trend, use a graphing calculator to find the regression line that best fits this data; recognize that the correlation coefficient measures goodness of fit and explain when it is appropriate to use the regression line to make predictions	M-H-A-5 Students will collect, organize, and display two-variable data, and use a line of best fit as a model to predict.		Construct a scatter plot of a set of paired data, and if it demonstrates a linear trend, use a graphing calculator to find the regression line that best fits this data; recognize that the correlation coefficient measures goodness of fit and explain when it is appropriate to use the regression line to make predictions
		M-H-A-9 Students will collect, organize, and display two-variable data, and use a curve of best fit as a model to make predictions.	<b>MA-H11-4.2.2</b> <b>Students will recognize and select the appropriate curve of best fit (linear, quadratic, exponential) for a set of two-variable data and will determine a line-of-best-fit equation and will use that equation to predict within and beyond a given set of data.</b>	
<b>1.7.2 Uncertainty &amp; Probability</b>	<b>L4. Explain and apply probability concepts and calculate simple probabilities:</b>	M-H-A-18 Students will use strategies such as combinations and permutations (arrangements) to count discrete quantities (the study of mathematical properties of sets and systems that have a countable number of elements).	<b>MA-M8-4.4.2</b> <b>Students will determine theoretical probabilities of simple events, will determine probabilities based on the results of an experiment, will make predictions, and will draw</b>	<b>I. Explain and apply probability concepts and calculate simple probabilities:</b>

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		<p>M-8-PS-9 Students will design and conduct probability experiments and interpret the results.</p>	<p><b>inferences.</b></p> <p><i>MA-M8-4.4.2a Students will tabulate experimental results from simulations and explain how theoretical and experimental probabilities are related.</i></p> <p><i>MA-M8-4.4.2b Students will determine theoretical probabilities and represent them using area models.</i></p>	
	<p><b>L4.1.</b> Explain how probability quantifies the likelihood that an event occurs in terms of numbers.</p>	<p>M-8-PS-6 Students will analyze situations, such as games of chance, board games, or grading scales, and make predictions using knowledge of probability.</p> <p>M-8-PS-7 Students will identify and describe the number of possible arrangements of several objects, using a tree diagram or the basic counting principle, and make a sample space represented in the form of a list, picture, chart, or a tree diagram.</p> <p>M-8-PS-8 Students will investigate and explain the role of probability in everyday decision making.</p> <p>M-8-PS-11 Students will determine theoretical</p>	<p><b>MA-H11-4.4.1</b> Students will determine theoretical and experimental (from given data) probabilities, will make predictions and draw inferences from probabilities, will contrast and compare theoretical and experimental probabilities, and will calculate probabilities involving replacement and non-replacement.</p> <p><i>MA-H11-4.4.1a Students will recognize or identify the differences between combinations and permutations and use them to count discrete quantities.</i></p>	<p>Explain how probability quantifies the likelihood that an event occurs in terms of numbers</p>



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		(mathematical) probabilities, Students will compare that to experimental results, and explain reasons why there might be differences (e.g., express probability as a ratio, decimal, percent as appropriate for a given situation).  M-7-PS-5 Students will determine appropriate techniques to use when investigating solutions to probability problems (using counting techniques; tree diagrams; area models; and exhaustive, organized lists, charts, and tables	MA-H11-4.4.1b <i>Students will represent probabilities in multiple ways, such as fractions, decimals, percentages, and geometric area models.</i>	
	L4.2. Explain how the relative frequency of a specified outcome of an event can be used to estimate the probability of the outcome.	M-8-PS-8 Students will investigate and explain the role of probability in everyday decision making.	MA-H11-4.4.1 Students will determine theoretical and experimental (from given data) probabilities, will make predictions and draw inferences from probabilities, will contrast and compare theoretical and experimental probabilities, and will calculate probabilities involving replacement and non-replacement.	Explain how the relative frequency of a specified outcome of an event can be used to estimate the probability of the outcome
	L4.3. Explain how the law of large numbers can be applied in simple examples.			Explain how the law of large numbers can be applied in simple examples.

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	L4.4. Apply probability concepts such as conditional probability and independent events to calculate simple probabilities.	M-8-PS-10 Students will explore concepts of randomness and independent events.	MA-H11-4.4.1a <i>Students will recognize or identify the differences between combinations and permutations and use them to count discrete quantities.</i>	Apply probability concepts such as conditional probability and independent events to calculate simple probabilities.
	L4.5. Apply probability concepts to practical situations to make informed decisions.	M-H-A-19 Students will design and conduct probability simulations, and interpret the results  M-8-PS-9 Students will design and conduct probability experiments and interpret the results.		Apply probability concepts to practical situations to make informed decisions.
1.10.4 Problem Solving Heuristics - Reasoning Skills - Connections to other disciplines	<b>Mathematical Reasoning:</b> Woven throughout the four domains of mathematics — Number Sense and Numerical Operations; Algebra; Geometry; and Data Interpretation, Statistics and Probability — are the following mathematical reasoning skills:			

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	MR1. Using inductive and deductive reasoning to arrive at valid conclusions.	<p><b>Mathematical reasoning</b> includes the use of logical skills in the context of testing conjectures, creating counter examples (an example that shows a general statement to be false), and composing and understanding valid arguments.</p> <p><b>Middle School Mathematical reasoning</b> includes deductive and inductive reasoning necessary in developing conjectures and validating arguments.</p>		
	MR2. Using multiple representations (literal, symbolic, graphic) to represent problems and solutions.	<p>M-H-A-3 Students will write and solve linear sentences, describing real-world situations by using and relating formulas, tables, graphs, and equations.</p> <p>M-8-A-2 Students will represent, interpret, and describe functional relationships through tables, graphs, and symbolic rules (input/output).</p> <p>M-8-A-9 Students will interpret and explain relationships between tables, graphs, verbal rules, and equations.</p>	<p>MA-H11-5.1.1 Students will identify and use multiple representations (tables, graphs, equations) of functions (linear, quadratic, absolute value, exponential) to solve real-world and/or mathematical problems.</p>	

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	<b>MR3.</b> Understanding the role of definitions, proofs and counterexamples in mathematical reasoning; constructing simple proofs.	<b>Mathematical reasoning</b> includes the use of logical skills in the context of testing conjectures, creating counter examples (an example that shows a general statement to be false), and composing and understanding valid arguments.		
	<b>MR4.</b> Using the special symbols of mathematics correctly and precisely.	<b>Mathematical communication</b> includes both words and symbols, enabling students to clarify their thinking, create definitions, share mathematical ideas, ask questions, and develop facility in using mathematical notation (letters and marks used in mathematics to name numbers, operations, sets, relations, and so on).		
	<b>MR5.</b> Recognizing when an estimate or approximation is more appropriate than an exact answer and understanding the limits on precision of approximations.			
	<b>MR6.</b> Distinguishing relevant from irrelevant information, identifying missing information and either finding what is needed or making appropriate estimates.			

TIMSS CONTENT	ADP Benchmarks: Mathematics	Kentucky Mathematics Program of Studies	Core Content for Assessment (Draft) Bold – State Assessment Content Statement <i>Italics – Supporting Content Statement</i>	Kentucky College Readiness Standards LEVELS: 1-2-3
	<b>MR7.</b> Recognizing and using the process of mathematical modeling: recognizing and clarifying mathematical structures that are embedded in other contexts, formulating a problem in mathematical terms, using mathematical strategies to reach a solution, and interpreting the solution in the context of the original problem.	<b>Problem solving</b> includes modeling and formulating problems based in real-world situations, within and outside mathematics, and aids in investigating and understanding mathematical content.		
	<b>MR8.</b> When solving problems, thinking ahead about strategy, testing ideas with special cases, trying different approaches, checking for errors and reasonableness of solutions as a regular part of routine work, and devising independent ways to verify results.			

<b>TIMSS CONTENT</b>	<b>ADP Benchmarks: Mathematics</b>	<b>Kentucky Mathematics Program of Studies</b>	<b>Core Content for Assessment (Draft)</b> <i>Bold – State Assessment Content Statement</i> <i>Italics – Supporting Content Statement</i>	<b>Kentucky College Readiness Standards LEVELS: 1-2-3</b>
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	<b>MR9.</b> Shifting regularly between the specific and the general, using examples to understand general ideas, and extending specific results to more general cases to gain insight.			
<b>1.10 Other Content</b>		<b>Mathematical connections</b> include the use of equivalent representations of a concept or a procedure and extend to both topics within mathematics and to other disciplines.		
Networks		<b>M-8-GM-6</b> Students will investigate counting techniques through shortest paths (e.g., networks).		
Matrices			<b>MA-H11-4.1.3a</b> <i>Students will represent real-world data using matrices and will use matrix addition, subtraction, multiplication (with matrices no larger than 2x2), and scalar multiplication to solve real-world problems.</i>	